

NASA Atmospheric Products for Weather and Climate Monitoring Temperature, Water Vapor, Clouds, Winds,

NASA Remote Sensing Training
Norman, Oklahoma
June 19-20, 2012

ARSET
Applied Remote SEnsing Training

A project of NASA Applied Sciences



Objective

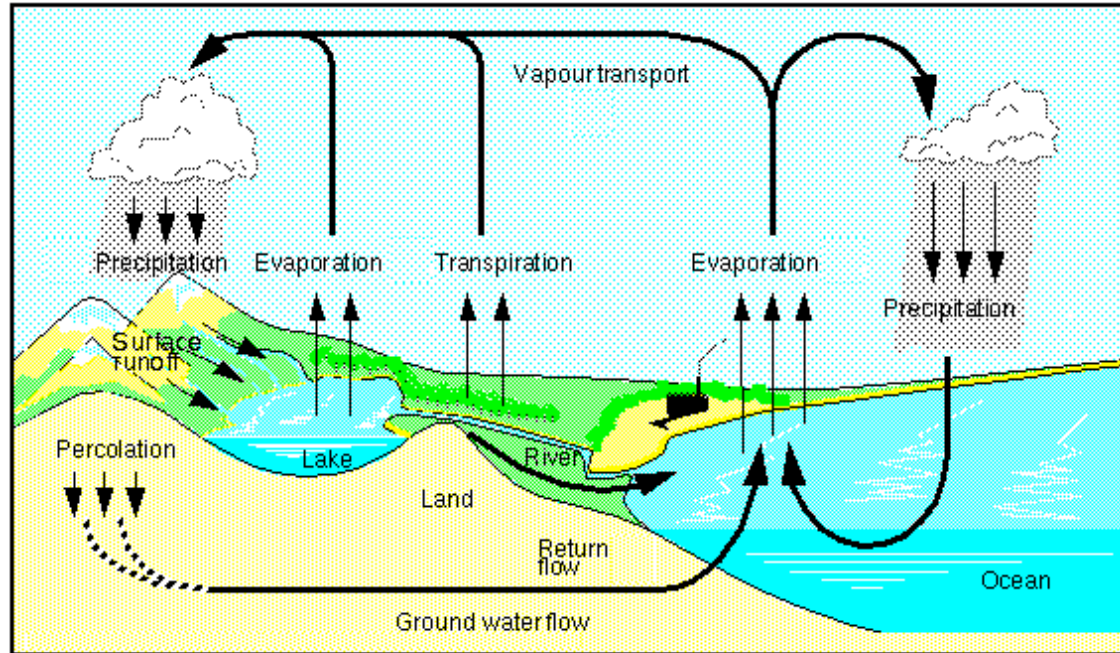
Present Overview of NASA satellites and models for atmospheric products

Present case studies of weather and climate studies

NASA Applied Sciences Program
Water Resources site: <http://wmp.gsfc.nasa.gov/>

NASA Water Products

- Rain
- Snow/Ice
- Water Vapor
- Clouds
- Soil Moisture
- Ground Water
- Snow/Ice
- Rain, Clouds, Water Vapor
- Soil Moisture
- Evaporation/Transpiration
- Run off



Courtesy Erich Roeckner, Max Planck Institute for Meteorology

Water Cycle Components

Products in red - derived from satellite measurements

Products in blue - derived from atmospheric/land surface models in which satellite measurements are assimilated

NASA Atmospheric Products

- **Precipitation:** Kg/m²/hour or mm/hour
- **Water Vapor:**
 - Column Integrated water vapor Kg/m²
 - Vertical profile of specific humidity Kg/Kg
 - Vertical profile of relative humidity Fraction
- **Clouds:**
 - Cloud Fractional Area Fraction
 - Cloud Top Pressure and Temperature hPa & Degree
- **Temperature:**
 - Ocean and Land Surface Temperature K or °C
 - Vertical profile K or °C
- **Winds:**
 - East-west and north-south wind components m/s
 - Surface wind and vertical profile of winds m/s

NASA Atmospheric Products

Source: Satellite measurements

Aqua/AIRS and MODIS : Temperature, Water Vapor, Clouds

Aqua/AMSR-E: Vertically Integrated Water Vapor

Terra/MODIS : Water Vapor, Clouds

Aqua and Terra are both polar orbiting satellites

Source: Satellite and Surface Data Assimilated Models

Modern Era Retrospective-Analysis for Research and Applications (MERRA): Temperature, Winds, Water Vapor, Clouds

NASA **Satellites** and **instruments** for Atmospheric Products

Satellites

Instruments

Products

**Terra/
Aqua**

- MODerate Resolution Imaging Spectroradiometer (MODIS)

Fractional Cloud Cover
Cloud Top Pressure/Temperature
Cloud Ice/Water Path, Cloud Optical Depth, Cloud Effective Radius
Column Integrated Water Vapor

Aqua

- Atmospheric Infrared Sounder (AIRS)

Fractional Cloud Cover
Cloud Top Pressure/Temperature
Column Integrated Water Vapor, Vertical Profile of Specific Humidity and Relative Humidity

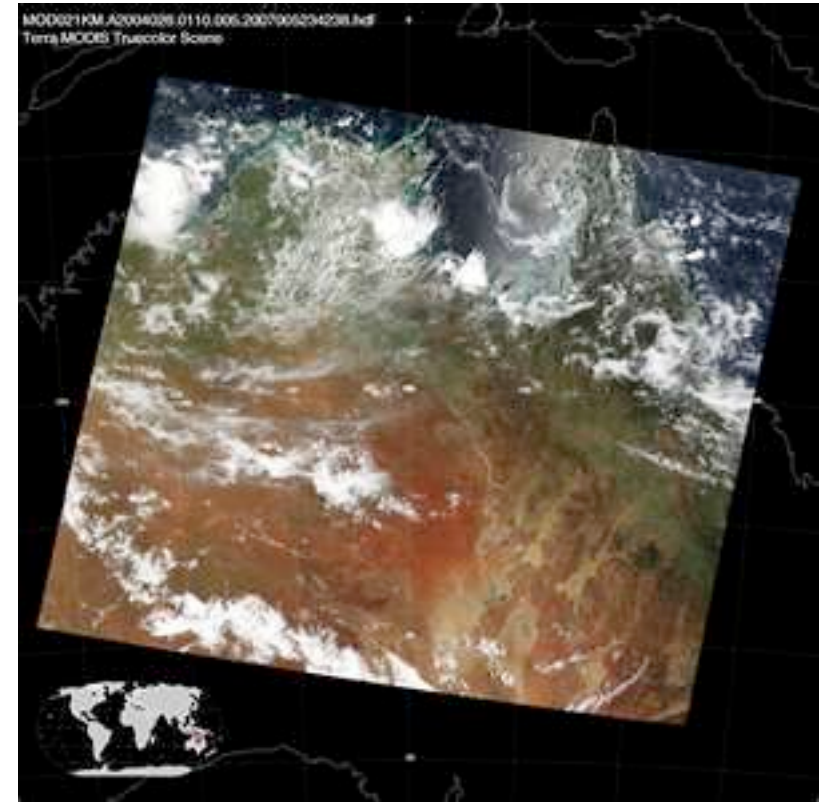
Aqua

- Advanced Microwave Scanning Radiometer for EOS (AMSR-E)

Column Integrated Oceanic Water Vapor, Sea Surface Temperature

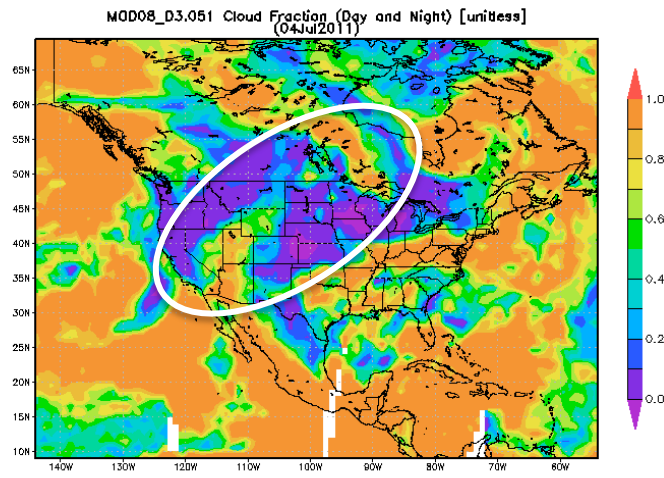
Terra and Aqua MODerate Resolution Imaging Spectroradiometer (MODIS)

- 36 spectral bands ranging from 0.41 to 14.385 microns.
- Products: Clouds, Column Integrated Water Vapor (for cloudy and cloud-free conditions)
- Measurement footprint – varies from 250 m to 1000 m
- Global, twice daily measurements [Terra 2000/03 to present, Aqua 2002/07 to present]

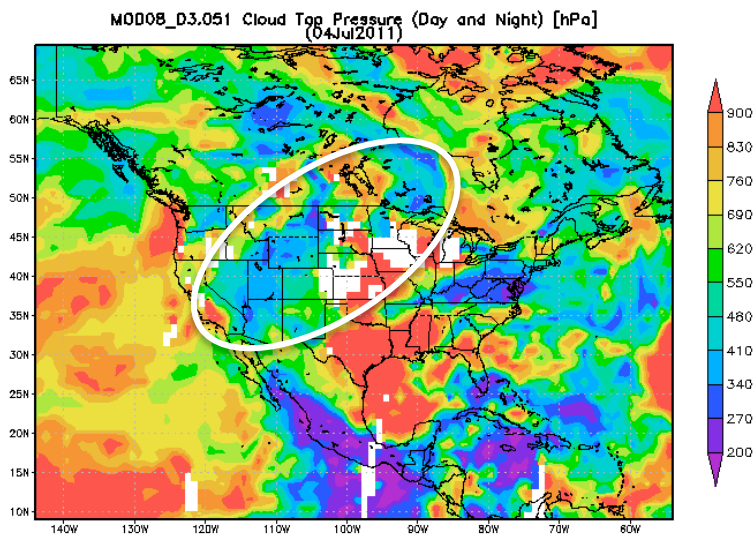


MODIS Image

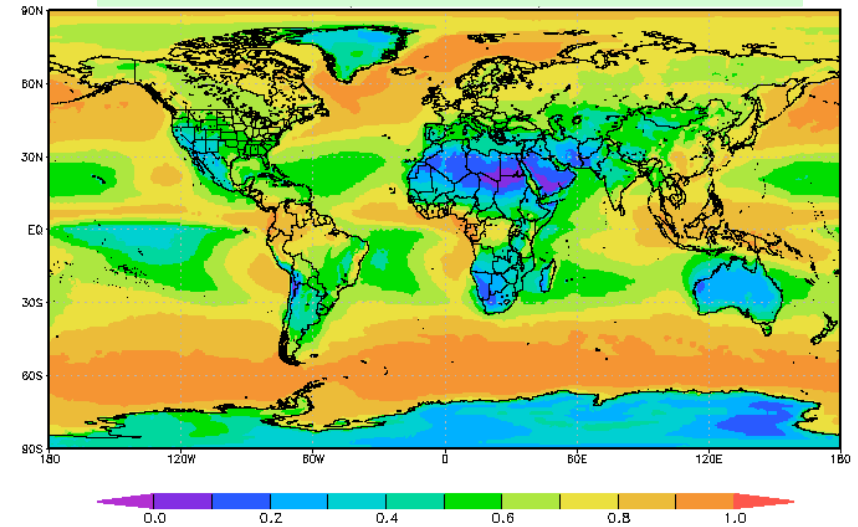
Terra and Aqua MODerate Resolution Imaging Spectroradiometer (MODIS) for Weather and Climate



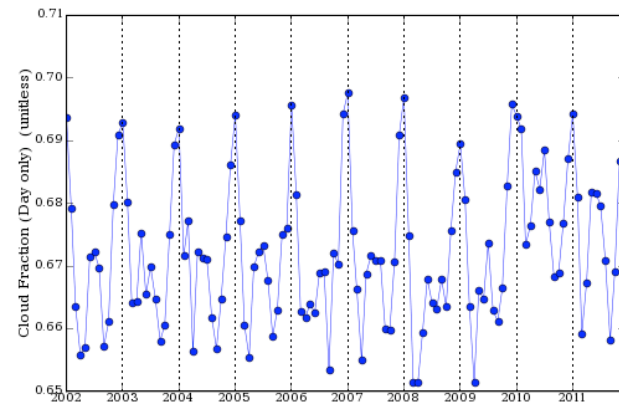
Cloud Fraction and Cloud Top Pressure for July 4, 2011



Time-mean Cloud Fraction Jan2003-Dec2011

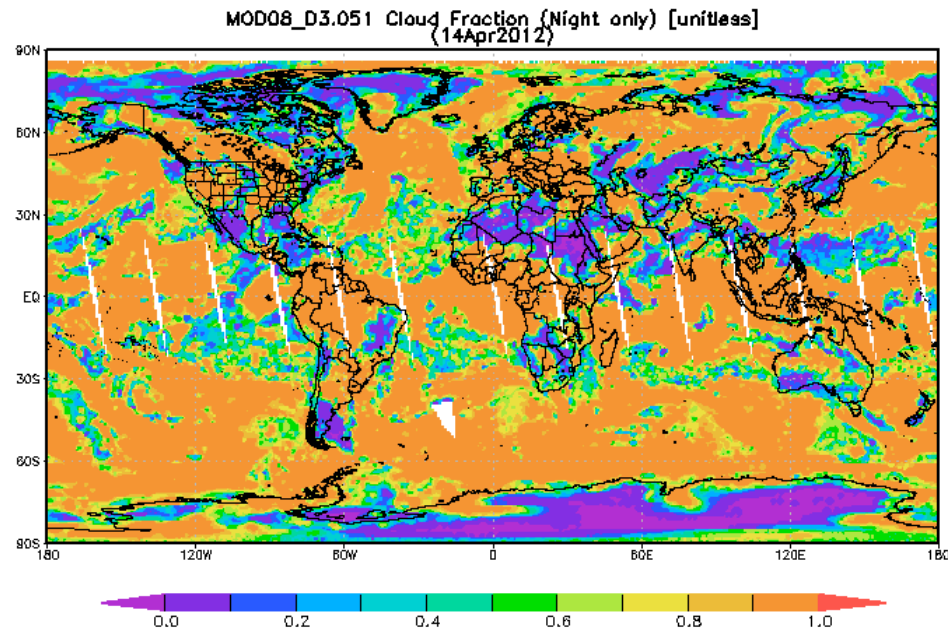
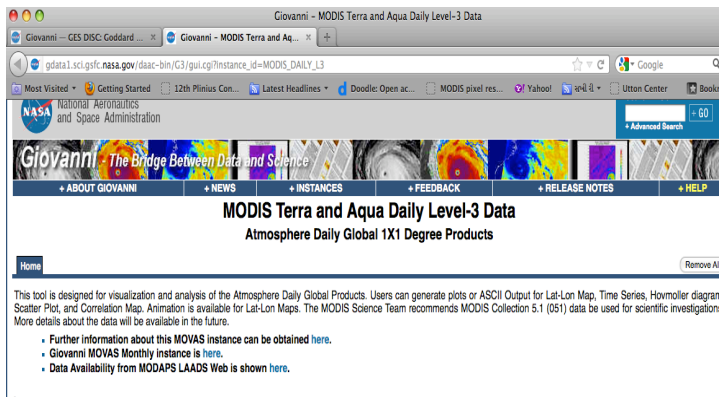


Area-Averaged Time Series (MOD08_M3.051)
(Region: 180W-180E, 90S-90N)

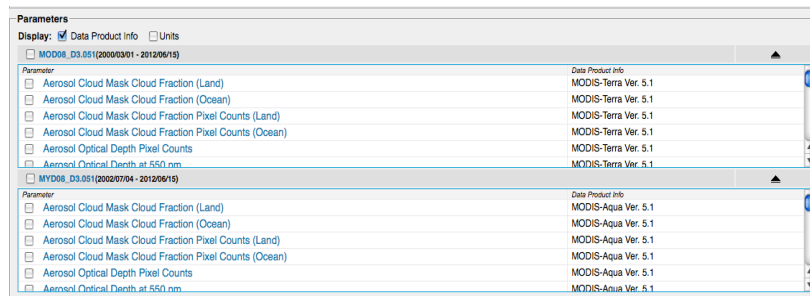


Terra and Aqua MODerate Resolution Imaging Spectroradiometer (MODIS)

- Gridded data at $1^\circ \times 1^\circ$ resolution, daily and monthly MODIS products are available from Giovanni



MODIS day/night average cloud fraction
April 14, 2012



MODIS Global Browser



http://ladsweb.nascom.nasa.gov/browse_images/global_browser.html

Global Browser

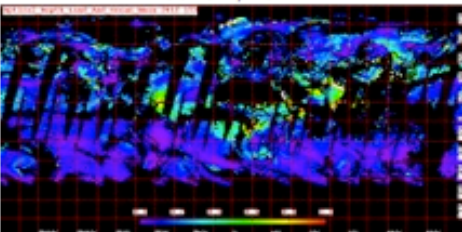
Satellite: Terra	Satellite: <input checked="" type="radio"/> Terra: <input type="radio"/> Aqua: <input type="radio"/> Combined: <input type="radio"/>	Month: Jun Year: 2012	Parameter: Cloud Fraction
Date: June 2012		Collection: 51 - Collection 5.1	<input type="button" value="Update"/>
Parameter: Aerosol Optical Depth			
Collection: 51			

Click on the thumbnail image to view a higher resolution image.

[+ View Help](#)

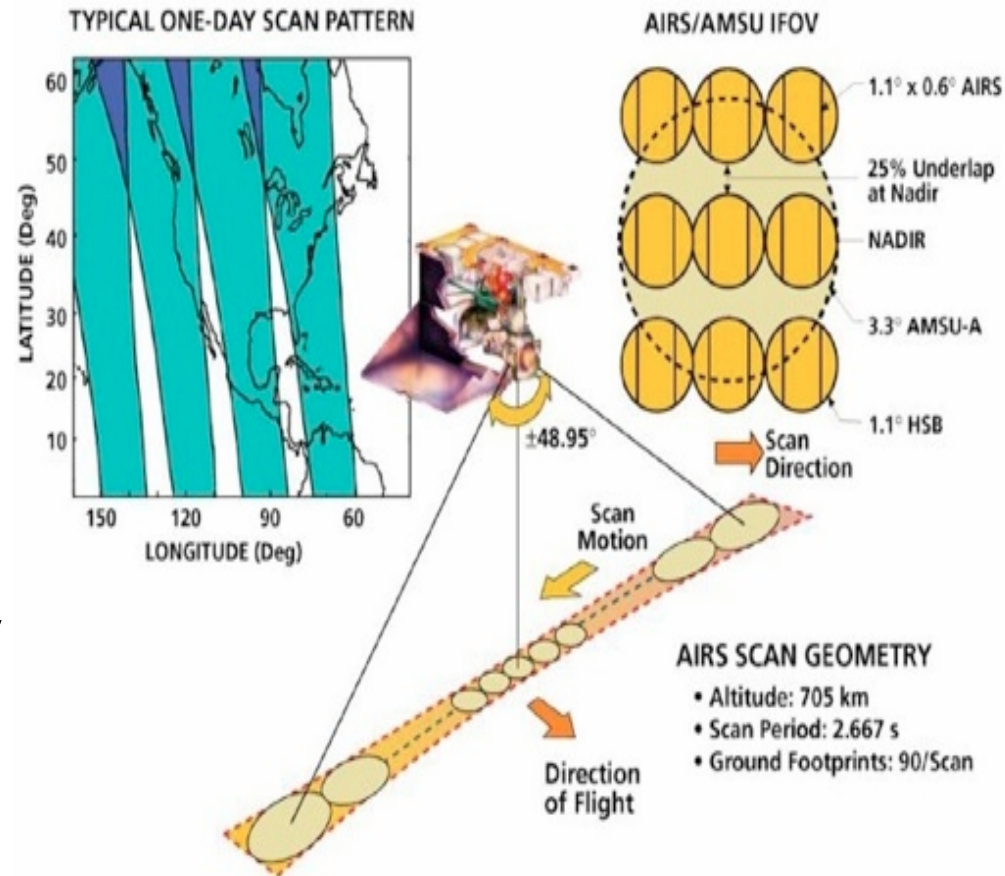
[+ Previous](#)

[+ Next](#)

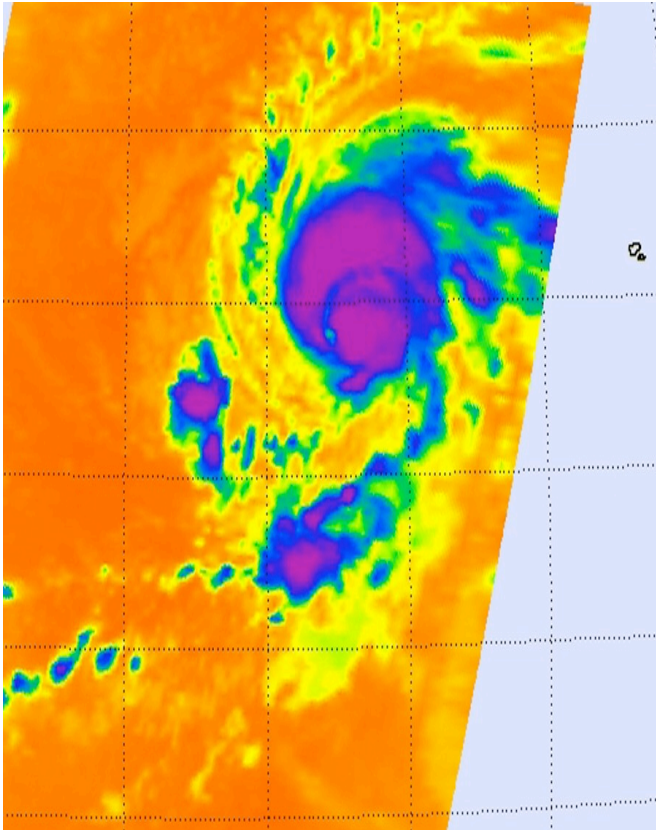
Daily	Eight-Day	Monthly
<div>June 1, 2012</div>  <div>MOD08_D3.A2012153.051.2012154092448.hdf</div> <div><input type="checkbox"/></div>		
<div>June 2, 2012</div>		

Aqua Atmospheric Infrared Sounder (AIRS)

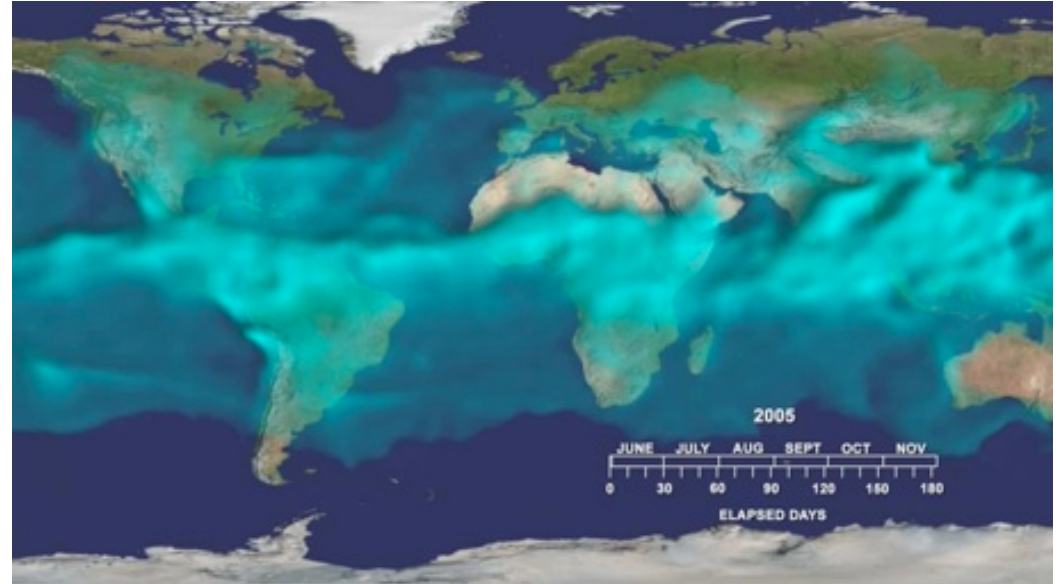
- Cutting-edge infrared technology with 2378 spectral bands in 0.5 to 15 micron
- Products: 3-dimensional maps of air and surface temperature, water vapor, and cloud properties.
- Measurement footprints vary from about 2.5 km to 14 Km
- Global, twice daily measurements [2002/07 to present]



Aqua Atmospheric Infrared Sounder (AIRS) for Weather and Climate



Hurricane Fred Observed by
AIRS: 9 September, 2009



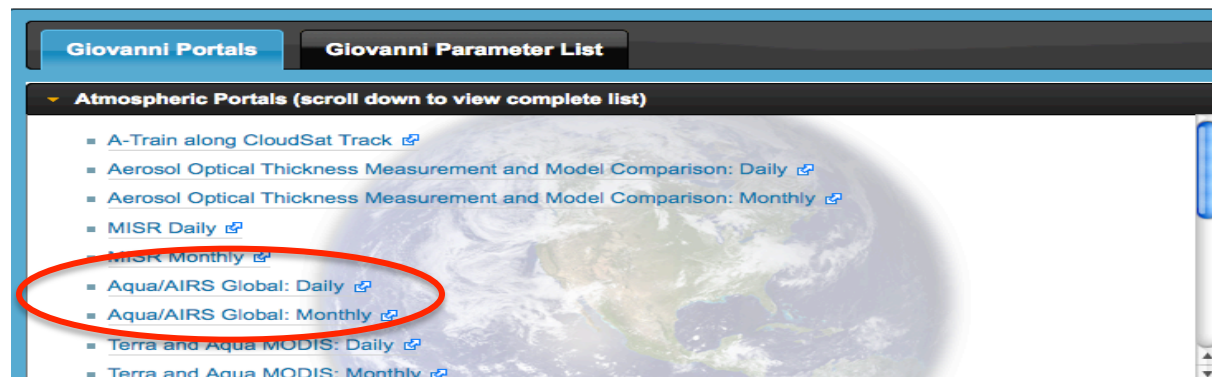
Variations in the three dimensional distribution of atmospheric water vapor, where higher altitudes appear brighter. Made with AIRS data retrieved during summer and fall, 2005.

Image credit: Dr. Vincent J. Realmuto, Earth Surface Science Group, JPL

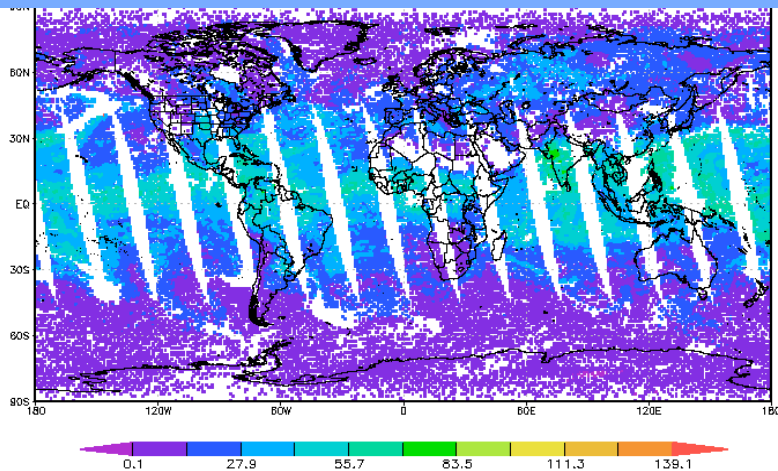
Aqua Atmospheric Infrared Sounder (AIRS)

- Gridded data at $1^\circ \times 1^\circ$ resolution, daily and monthly AIRS products are available from Giovanni

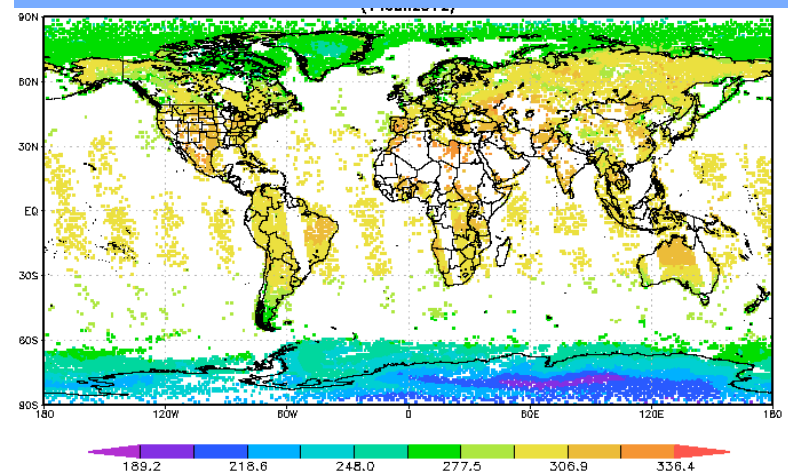
Giovanni



Total Column Water Vapor (mm): June 14, /2012

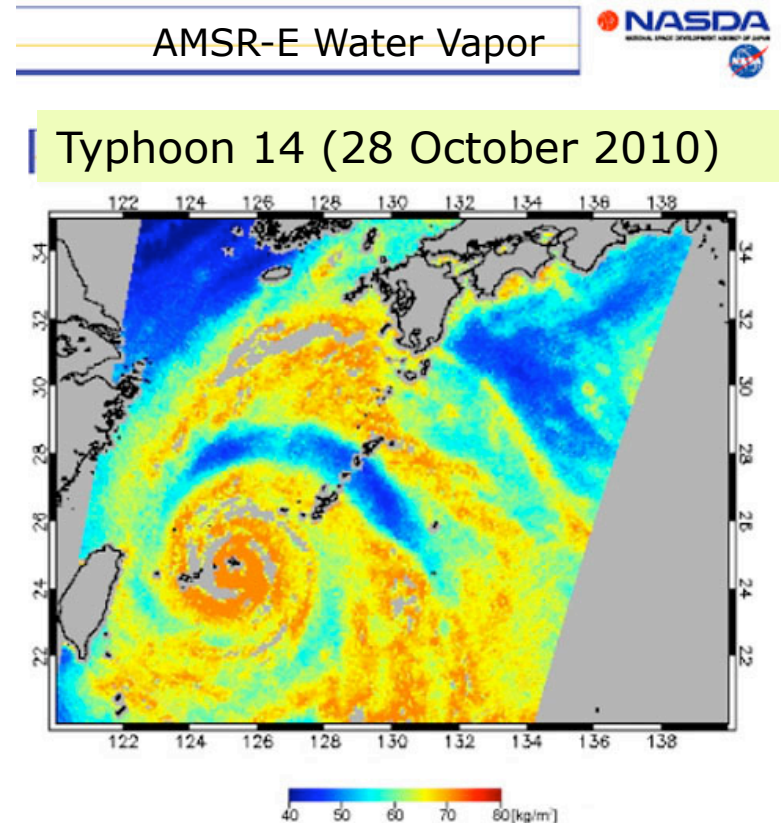


Surface Skin temperature (K): June 14, 2012



Aqua Advanced Microwave Scanning Radiometer for EOS (AMSR-E)

- Twelve-channel, six-frequency, passive-microwave 6.925, 10.65, 18.7, 23.8, 36.5, and 89.0 GHz
- Provides ocean surface temperatures, total column atmospheric moisture over ocean



Since observations of precipitation and water vapor over the oceans far from land are very sparse, AMSR-E measurements are expected to be incorporated into the numerical weather forecast models and contribute to improving predictions of typhoon tracks and weather forecasts. In addition, AMSR-E, in combination with the AMSR on board Midori-II, provides more frequent observation.

MERRA: Modern Era Retrospective-analysis for Research and Application

- Satellite and surface measurements assimilated model
- Products: 3-dimensional maps of air temperature, humidity, winds. Also provides 'modeled' clouds and precipitation
- Spatial resolution: Spatial Resolution: $2\frac{1}{3}^{\circ} \times 1\frac{1}{2}^{\circ}$, $1.25^{\circ} \times 1.25^{\circ}$ (approximately $66 \times 50 \text{ km}^2$, $125 \times 125 \text{ km}^2$)
- Global, hourly, daily, monthly data [1979/01 to present]

FIND MORE INFORMATION ON
MERRA
AT
<http://gmao.gsfc.nasa.gov/merra>

MERRA products are available online through the Goddard Earth Sciences Data and Information Services Center:
<http://disc.sci.gsfc.nasa.gov/mdisc/data-holdings>

MERRA was conducted at the NASA Center for Climate Simulation (NCCS).

The GMAO works to maximize the impact of satellite observations in the analysis and prediction of climate and weather through integrated Earth system modeling and data assimilation.

GLOBAL MODELING AND ASSIMILATION OFFICE

Code 610.1

NASA/Goddard Space Flight Center

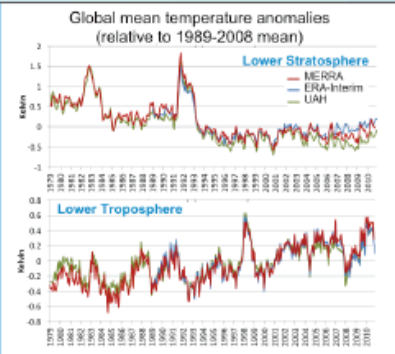
Greenbelt, MD 20771

<http://gmao.gsfc.nasa.gov>

MERRA

The Modern-Era Retrospective analysis for Research and Applications

Global mean temperature anomalies (relative to 1989-2008 mean)




Lower Stratosphere

Lower Troposphere

Global Modeling and Assimilation Office

Goddard Space Flight Center



MERRA: Modern Era Retrospective-analysis for Research and Application

Hourly, Monthly products are available from Giovanni

Giovanni

Giovanni Portals

Giovanni Parameter List

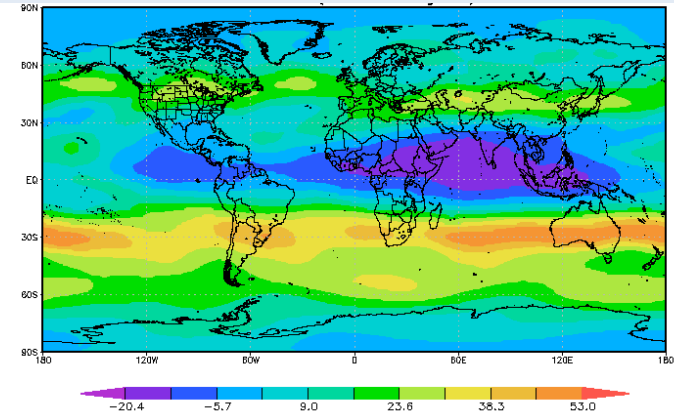
► Atmospheric Portals (scroll down to view complete list)

► Application and Education Portals

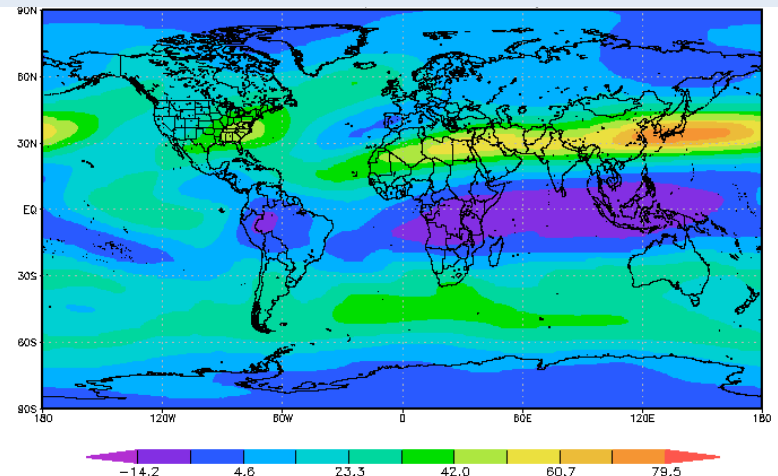
▼ Meteorological Portals

- [Modern Era Retrospective-Analysis for Research and Applications \(MERRA\): 2D Monthly](#)
- [Modern Era Retrospective-Analysis for Research and Applications \(MERRA\): 3D Monthly](#)
- [MERRA Monthly Analysis](#)
- [MERRA Monthly Chemistry Forcing](#)
- [MERRA Hourly 2D](#)
- [MERRA Hourly 3D](#)
- [TRMM Online Visualization and Analysis System \(TOVAS\)](#)
- [Clouds and the Earth's Radiant Energy System \(CERES\)](#)

Upper level east-west wind: JJA 2011



Upper level east-west wind: DJF 2011-12



Obtain MERRA, MODIS, AIRS Products

Can be downloaded from <http://mirador.gsfc.nasa.gov> by a keyword search. Also, can search by time and location/region

The screenshot shows the Mirador Earth Science Data Search Tool interface. The browser address bar displays <http://mirador.gsfc.nasa.gov/>. The page features a navigation menu on the left with options like Overview, Help Center, Data Holdings, and View Cart. The main search area includes fields for Keyword (TRMM), Location ([-45,-76],[15,-50]), and Time Span (From: 2011/05/14, To: 2011/05/21). A world map is visible on the right. The bottom section lists available data products (AIRS, OMI, MLS, etc.) and latest news.

Search Criteria:

- Keyword: TRMM
- Location: [-45,-76],[15,-50]
- Time Span: From: 2011/05/14, To: 2011/05/21

Available Data: AIRS, OMI, MLS, HIRDLS, TOMS, UARS, TRMM, GLDAS, SORCE, Subsets from A-Train Sensors (e.g. MODIS, AIRS, OMI and MLS), MERRA, GOCART, LIMS, MSU, NEESPI, NLDAS, SSBUV, SBUV, TOVS, ACOS, MEASUREs

What's New: Quality Screening for AIRS Level 2 Products is now combined with Variable Subsetting and NetCDF Conversion

Acknowledgements:

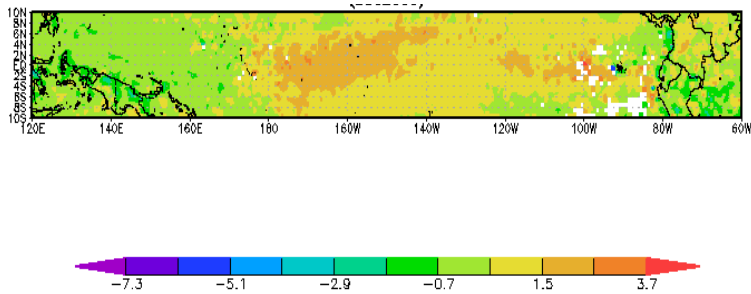
- Location Gazetteer data from: National GeoSpatial Information Agency
- Events Gazetteer data from: Unisys, EPA and Smithsonian Global Volcanism Program

LATEST NEWS

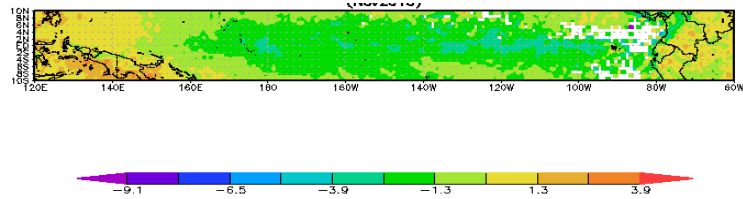
- 2011-11-03T17:58:49Z - TRMM Version 7 data are now available
Tropical Rainfall Measuring Mission provides vital precipitation data
[Read More](#)
- 2011-11-03T14:35:18Z - Research papers utilizing Giovanni appear in a flurry during autumn 2011
Total number of papers exceeds 400; 2011 citations already equal 2010 tally
[Read More](#)
- 2011-10-21T17:07:59Z - ACOS in preparation for new release of CO2 data
ACOS Team is preparing to release data from the new version 2.9 build
[Read More](#)

Case Study: Inter-annual Variability

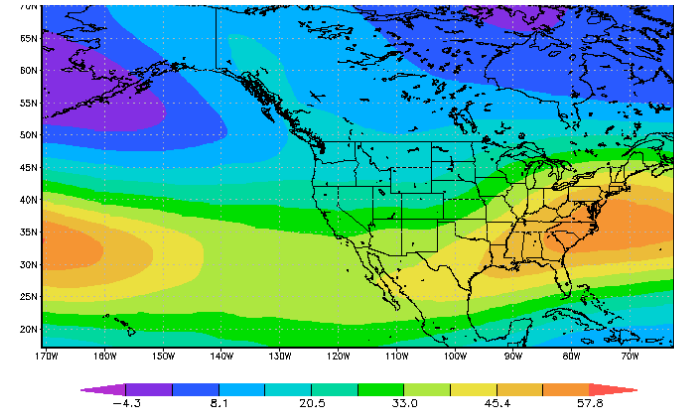
El Niño Condition in Dec 2009
AIRS Sea Surface Temperature (K)



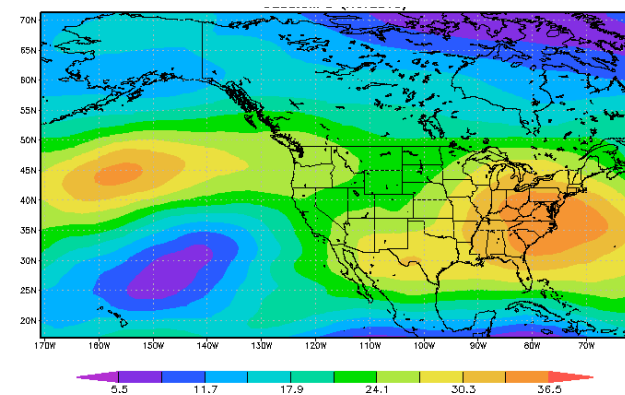
La Niña Condition in Nov 2010
AIRS Sea Surface Temperature (K)



MERRA Upper Level East-West Winds
Dec 2009

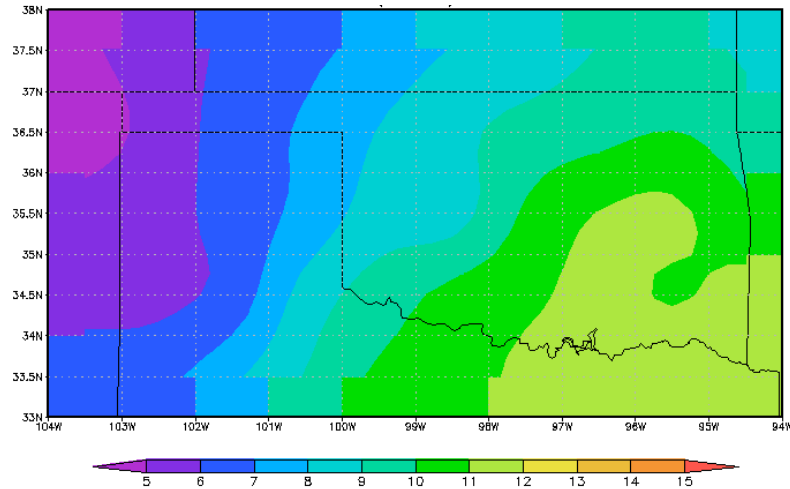


MERRA Upper Level East-West Winds
Nov 2010

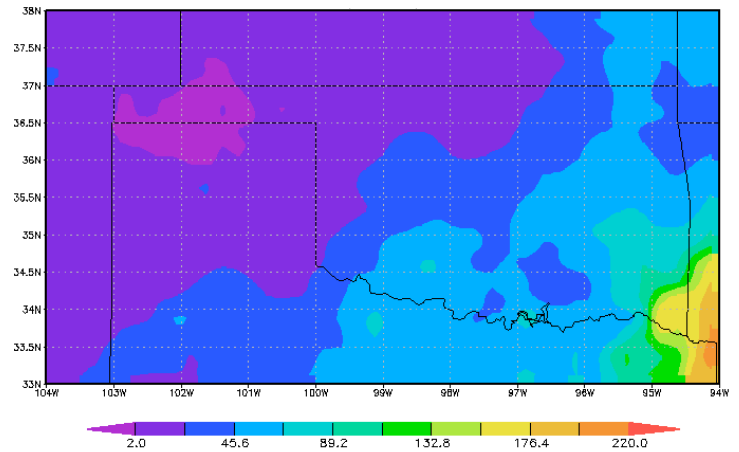


Case Study: Inter-annual Variability

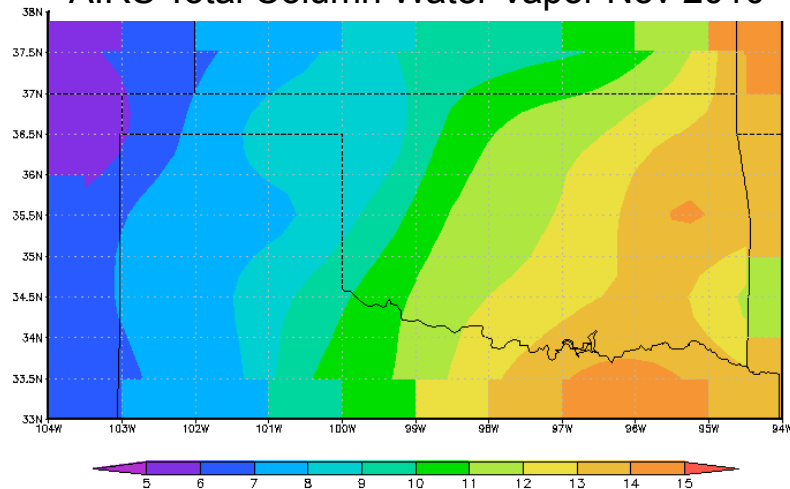
AIRS Total Column Water Vapor Dec 2009



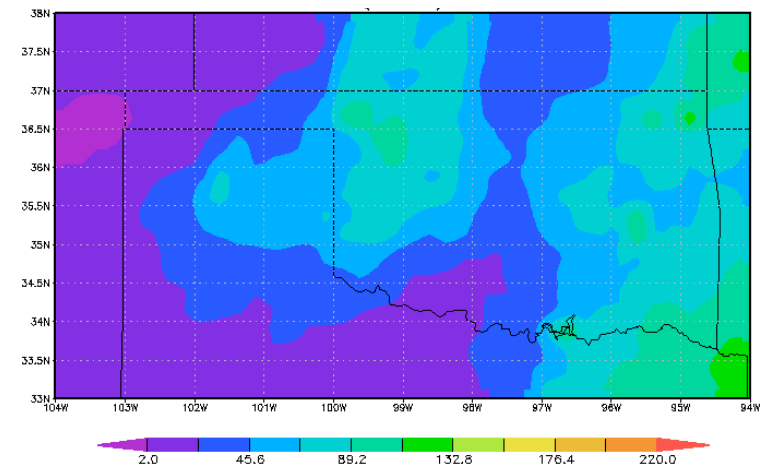
TRMM Rain Dec 2009



AIRS Total Column Water Vapor Nov 2010



TRMM Rain Nov 2010



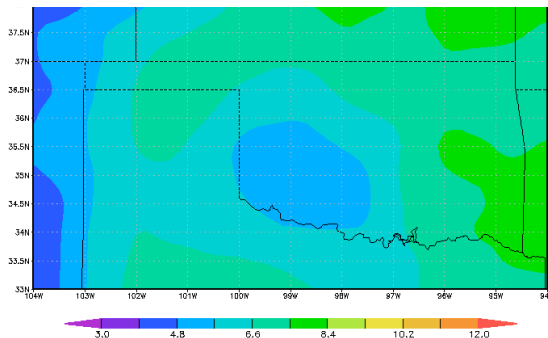
Case Study: Severe Weather over eastern Oklahoma (13-14 April 2011)



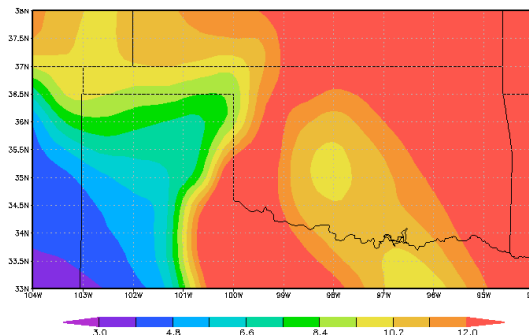
The Tushka, Oklahoma tornado.
 34.3203° N, 96.1669° W

MERRA Moisture

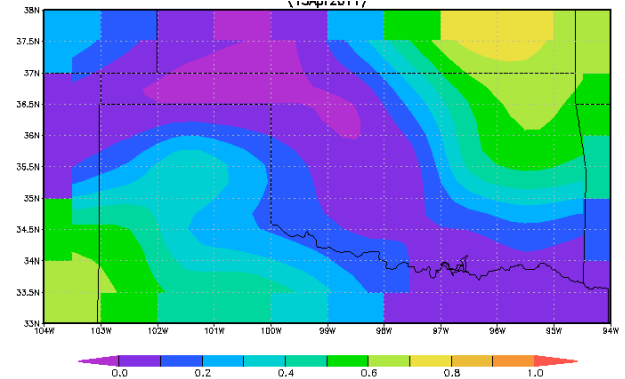
4/13/2011



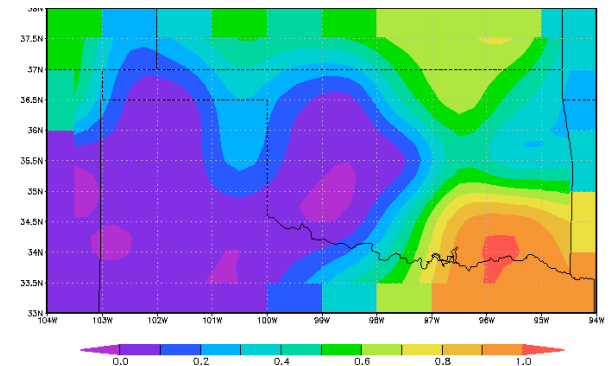
4/14/2011



MODIS Cloud Fraction 4/13/2011



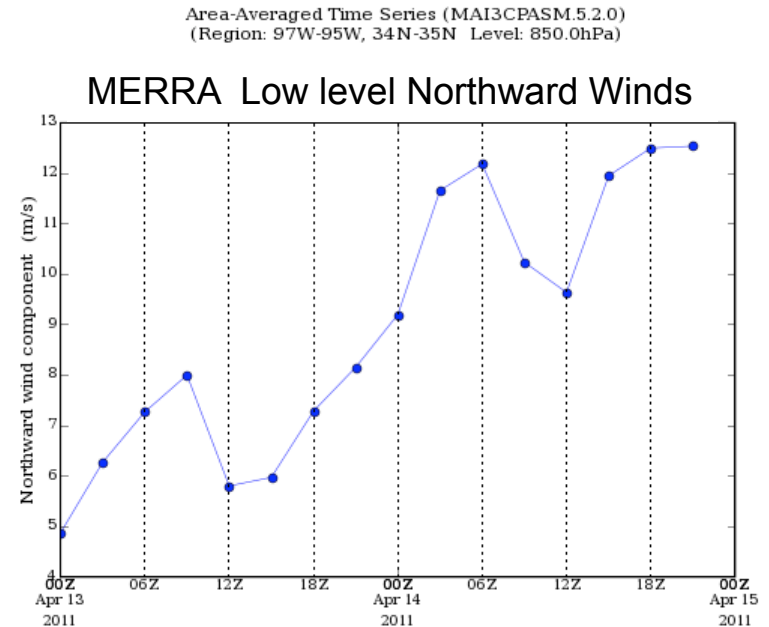
MODIS Cloud Fraction 4/14/2011



Case Study: Severe Weather over eastern Oklahoma (13-14 April 2011)



The Tushka, Oklahoma tornado.
34.3203° N, 96.1669° W



Increase in low level
winds around Tushka

Summary

NASA Atmospheric Products can be used to conduct case studies associated with weather and climate conditions and develop scenarios, for developing potential mitigation strategies at the regional level

Thank You!